AIS
तेजस्वि नावधीतमस्तु

SENSE 'N' SCIENCE

Under the Water

Volume 13

8 most exciting topics

including deep sea gigantism, hydrothermal vents, ocean dynamics and much more

Interactive puzzles

including crosswords, word search and trivias!

Contents

Editor's Note

"*Out there past men's knowing, where the stars are drowning and whales ferry their vast souls through the black and seamless sea,*"

-Cormac McCarthy, *Blood Meridian*

Azure waters reign over our planet and yet we known so little about the seemingly endless worlds hidden beneath their waves. In this edition, we'll explore the phenomena of our seas and oceans, such as hydrothermal vents, bioluminescence, immortal underwater creatures and deep sea gigantism. Hopefully this issue encourages you to delve deeper into underwater science and fight for our drying oceans.

We'd like to thank all the curious minds that contributed to this magazine, and our teachers for their guidance.

Now go on ahead and dive in to this mysterious, underwater world!

Editors: Dhyaana Shah, Aditya Saini

Designers: Aashvi Patel, Piya Patel, Paarth Gopalka

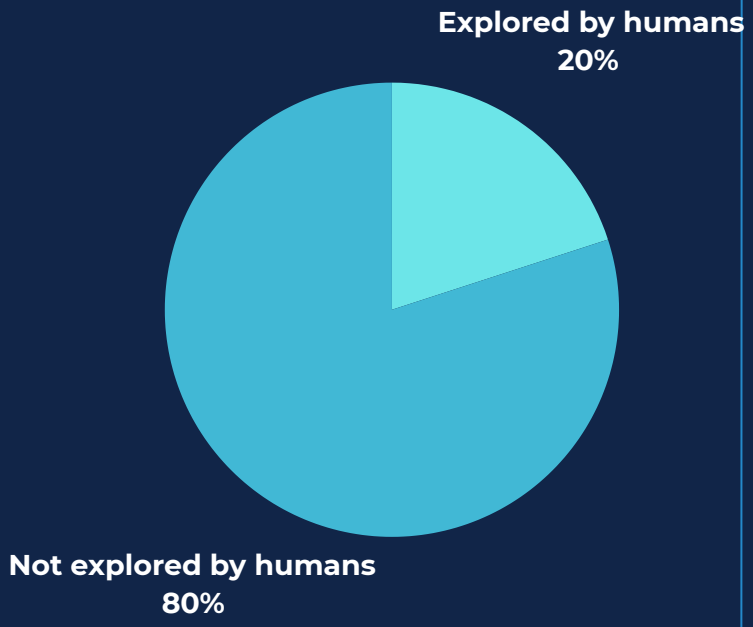
Proofreaders: Bhavy Shah, Hridhay Thakkar

Teacher Incharges: Ms. Meenu Gupta, Dr. Kinjal Shah

How much have humans explored?

Tanish Satpal, IGCSE 8A

Covering over 70% of the Earth's surface, Oceans are vast and deep — tilled with mysteries. Even with the technology of today, only 20% (or so) has been explored by human beings on this Earth and many regions remain unknown. The secrets that the underwater world of our planet conceals — marine flora and fauna, unique geological structures, people rich in resources so needed by future generations. Here we go into how much of us has been peered, what else hidden under the depths.



The History of Underwater Exploration

The human fascination with the ocean dates back to the ancient times when sailors ventured into the seas, but it wasn't until the 19th and 20th centuries that we began to understand what lies beneath. Earlier explorations were limited to coastal waters, but with the invention of the bathyscaphe—a deep-sea submersible—humans made their first ventures into the deep. In 1960, Jacques Piccard and Don Walsh famously descended to the bottom of the Mariana Trench, the deepest point on Earth.

Since then, several expeditions have revealed stunning underwater landscapes, from massive underwater mountain ranges to hydrothermal vents.

Despite these breakthroughs, the oceans' sheer vastness means that most of its depths are still unexplored. This is largely because exploring the deep ocean is a monumental challenge that requires sophisticated technology.

The Depths of Exploration

We humans have mapped only about 20% of the ocean floor in detail, leaving around 80% of it still largely unknown. This is surprising when compared to space exploration, where we have detailed maps of planets like Mars.

The ocean's greatest depths, such as the Mariana Trench, plunge to around 11,000 meters below sea level, making it one of the least accessible places on Earth. Most of the human activity has taken place in the shallow zones near coastal areas, where marine life and underwater habitats are most easily studied.

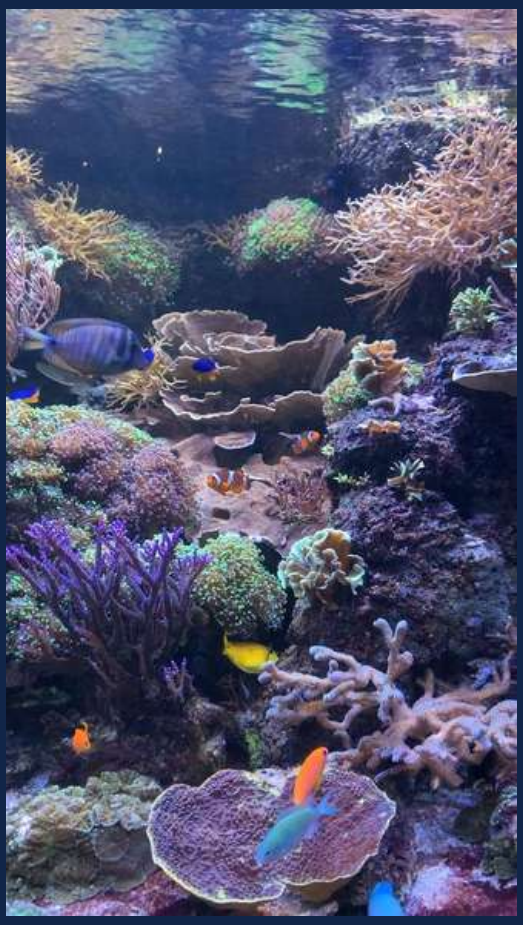
Advanced underwater exploration has revealed astonishing marine biodiversity, especially in the deep ocean. Creatures like the anglerfish, bioluminescent jellyfish, and giant squid are some of the fascinating species that have adapted to live in these extreme environments. There's a high possibility that thousands of species remain undiscovered in the ocean's dark, cold depths.

Challenges of Deep-Sea Exploration

Exploring the deep ocean is similar to going into space. The conditions are harsh—temperatures drop to near-freezing, and pressure can be over 1,000 times higher than at the surface. These harsh environments pose significant risks to both human explorers and technology. Specially designed equipment is required to withstand the crushing pressure of the deep ocean. Furthermore, the ocean's vast size makes exploration time-consuming and costly. Deep regions are vast and inaccessible, so even with advanced technology, we have only scratched the surface of what lies beneath. The lack of light below 1,000 meters adds to the difficulty, forcing explorers to rely on artificial light sources.

What's Left to Discover?

While we have made remarkable discoveries, the ocean still holds countless secrets. Many marine scientists believe that the majority of the ocean's species are yet to be discovered. Deep-sea ecosystems, like hydrothermal vent communities and underwater caves, are largely unexplored. These environments may hold clues to how life began on Earth and provide insights into the potential for life on other planets.



Even with the tremendous technological and exploratory advances made by humanity, the ocean is still one of Earth's last frontiers. The majority of this underwater world remains unknown, with only 20% of the ocean having been explored. Deepwater exploration is crucial for both scientific advancement and the planet's long-term sustainability. The creation of new technologies and global cooperation will be essential in the future to uncovering the mysteries of the deep ocean. While we wait, the mysteries hidden beneath the waves never cease to astound and inspire us, serving as

Hydrothermal Vents

Naysha Paneri , IGCSE 8C

Hydrothermal vents are fascinating underwater geysers located in the deepest parts of the ocean. They release superheated, mineral-rich water into the surrounding seawater, creating a unique and extreme environment characterized by high pressure, complete darkness, and toxic chemicals. Despite these harsh conditions, hydrothermal vents are home to diverse forms of life that have adapted remarkably to survive. This remarkable adaptability not only showcases the resilience of life on Earth but also provides insights into potential life beyond our planet.

What are Hydrothermal Vents?

Hydrothermal vents are formed in volcanic regions on the ocean floor, typically along tectonic plate boundaries. When seawater seeps into cracks in the ocean crust, it is heated by underlying magma and rises back up, carrying dissolved minerals. Upon mixing with the cold ocean water, this hot, mineral-laden water creates chimney-like structures known as "black smokers" or "white smokers," depending on the types of minerals they contain. Black smokers emit dark clouds of particulate matter due to high concentrations of sulfide minerals, while white smokers release lighter-colored fluids rich in barium, calcium, and silica. These vents can reach temperatures exceeding 400°C (752°F) and are often surrounded by a variety of geological formations, including rugged rock formations and expansive fields of mineral deposits. The unique geology of hydrothermal vent systems contributes to their biological diversity and ecological significance.

The Unique Chemistry of Hydrothermal Vents

The water expelled from hydrothermal vents is rich in minerals such as sulfur, iron, and manganese and is often acidic. These extreme conditions are inhospitable for most organisms; however, they support unique ecosystems. The chemical reactions between the vent water and seawater provide a source of energy that fuels life through a process called chemosynthesis. In this process, organisms produce food without sunlight by utilizing chemicals from the vent fluids.

Chemosynthetic bacteria form the base of this food web. They convert inorganic compounds like hydrogen sulfide into organic matter, which serves as food for other organisms in the ecosystem. This process is fundamentally different from photosynthesis, which relies on sunlight as an energy source. The discovery of chemosynthesis has revolutionized our understanding of how life can exist in environments previously thought to be uninhabitable.

Life at Hydrothermal Vents

Despite the extreme environment, hydrothermal vents are teeming with life. Some of the unique organisms found in these ecosystems include:

- Giant Tube Worms: These remarkable creatures can grow over two meters long and lack a digestive system. Instead, they harbor symbiotic bacteria that convert chemicals from the vent into energy. The tube worms have a specialized organ called a trophosome that houses these bacteria.
- Vent Shrimp: Equipped with specialized eyes that can detect faint infrared light emitted by the vents, these shrimp thrive in this unusual habitat. They play an essential role in the ecosystem by feeding on organic material produced by chemosynthetic bacteria.

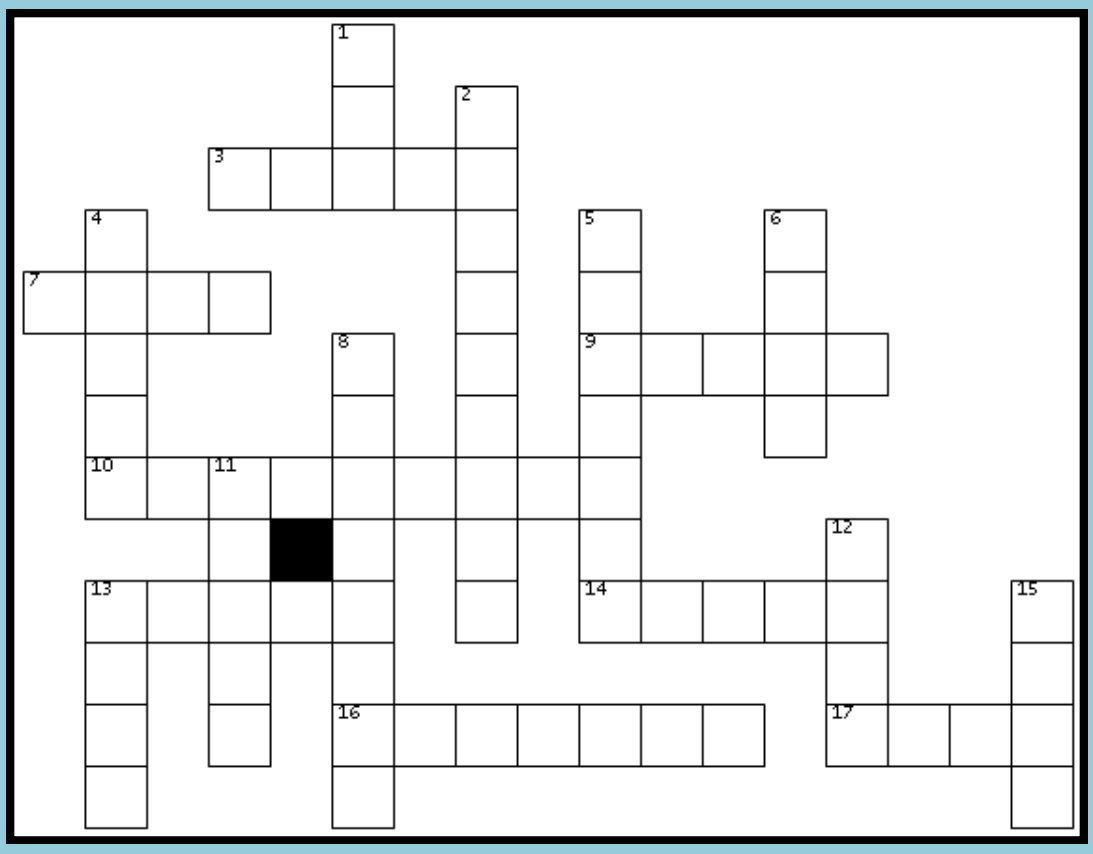
Pompeii Worms: Known as one of the most heat-tolerant animals on Earth, Pompeii worms can survive temperatures as high as 80°C (176°F) and have developed adaptations to cope with their extreme environment. Their bodies are covered with a thick layer of bacteria that may help protect them from heat and toxins.

Other Unique Species: Hydrothermal vents also host various other organisms such as clams, mussels, and various types of crabs that have adapted to these extreme conditions. Many of these species rely on symbiotic relationships with chemosynthetic bacteria for their survival.
These organisms form intricate relationships within their ecosystems, showcasing the complex interactions that sustain life at hydrothermal vents.

Hydrothermal vents exemplify the incredible adaptability of life on Earth, thriving in one of its most extreme environments. The study of these unique ecosystems not only helps scientists understand how life can flourish under harsh conditions but also provides clues about the potential for life beyond our planet. As we continue to explore and learn about hydrothermal vents through advanced technologies and innovative research methods, we unlock secrets that could reshape our understanding of biology and astrobiology alike.

Take on a challenge!

Pratham Vora , IGCSE 8D

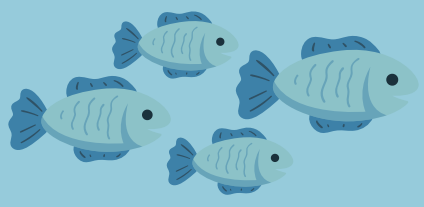


ACROSS

3. Very big ocean animal that can sing
7. Something fish have that helps them swim
9. Deep place in the ocean
10. A machine that explores the deep sea
13. Large fish with sharp teeth
14. Person who swims under the water
16. Sea animal with eight arms
17. The colour of the ocean

DOWN

1.Large body of salty water
2. Underwater creature with many arms and stings
4. Big waves that go up and down
5. Tall sea plant that moves with the waves
6. Something you wear on your face to see underwater
8. Small fish food that floats near the surface
11. Sandy area at the edge of the water
12. Small sea creature that lives in a shell
13. Cute sea animal with flippers and whiskers
15. Colorful underwater "garden" made by tiny animals



***Answers at the end**

Environmental Conditions at Different Depths

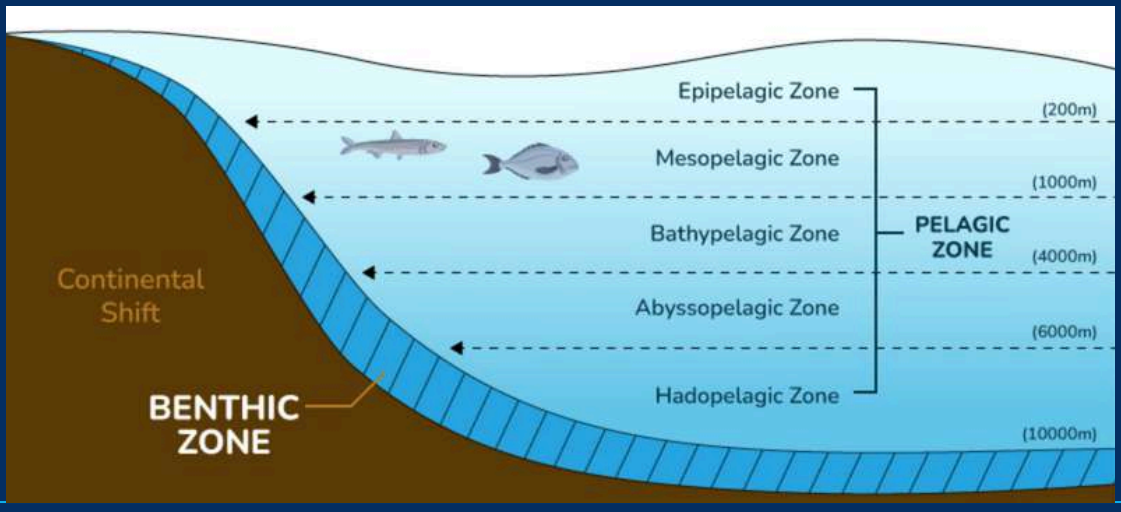
Veeva Shah, IGCSE 8D

Epipelagic Zone

This surface layer is also called the sunlight zone and extends from the surface to 200 meters (660 feet). It is in this zone that most of the visible light exists. With that sunlight comes heat from sun, which is responsible for wide variations in temperature across this zone, both with the seasons and latitudes - sea surface temperatures range from as high as 97°F (36°C) in the Persian Gulf to 28°F (-2°C) near the North Pole.Wind keeps this layer mixed and thus allows the sun's heat to be distributed vertically. It is inhabited by a wide variety of marine forms, including eels, fishes, mollusks, and others

Mesopelagic Zone

Below the epipelagic zone is the mesopelagic zone, extending from 200 meters (660 feet) to 1,000 meters (3,300 feet). The mesopelagic zone is sometimes referred to as the twilight zone or the midwater zone, as sunlight this deep is very faint. Temperature changes are the greatest in this zone because it contains thermocline, a region where water temperature decreases rapidly with increasing depth, forming a transition layer between the mixed layer at the surface and deeper water. The depth and strength of the thermocline varies from season to season and year to year. It is strongest in the tropics and decreases to non-existent in the polar winter season. Because of the lack of light, production and emission of light by living organisms begins to appear in this zone. A great diversity of strange and bizarre fishes can be found here.



Bathypelagic Zone

The depths from 1,000-4,000 meters (3,300 - 13,100 feet) comprise the bathypelagic zone. Due to its constant darkness, this zone is also called the midnight zone. The only light at this depth and lower comes from the bioluminescence of the animals themselves.
The temperature in the bathypelagic zone, unlike that of the mesopelagic zone, is constant. The temperature never fluctuates far from a chilling 39°F (4°C). The pressure in the bathypelagic zone is extreme and at depths of 4,000 meters (13,100 feet), reaches over 5850 pounds per square inch. Yet, sperm whales can dive down to this level in search of food. Most of the animals that live at these depths are black or red in colour due to the lack of light. Life that exists in this zone must be able to function in cold temperatures and withstand extreme hydrostatic pressure. Pressure varies with depth, and in this zone, it ranges from 100 to 400 atmospheres. Despite the extreme environment, organisms here must find food and mates and avoid predators, just as they do in any ecosystem, and they have special adaptations that allow them to do so. These include well developed visual systems, bioluminescence used both to lure prey and attract mates, and well-developed auditory systems that allow them to hear other animals moving nearby.

Abyssopelagic Zone

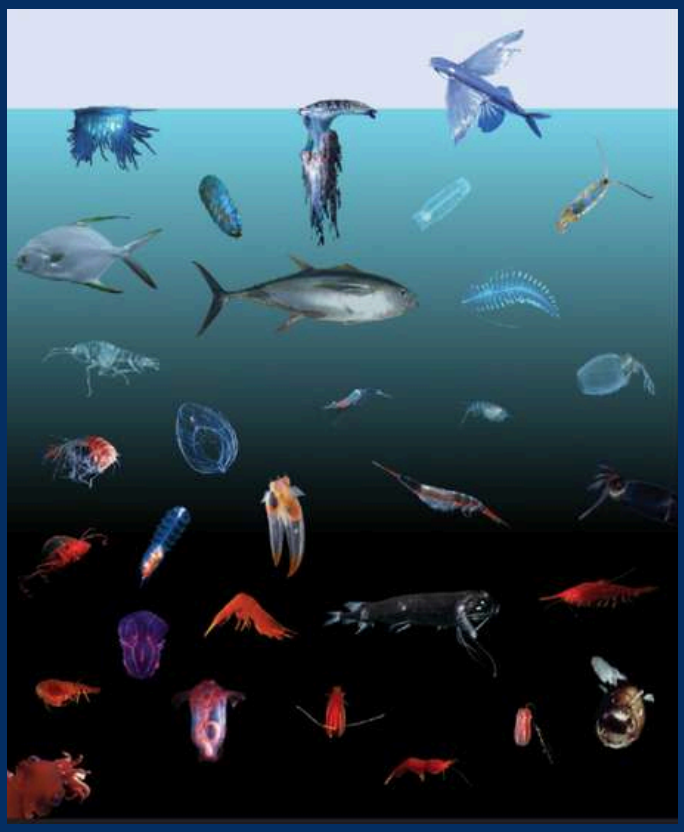
The Abyssopelagic Zone (or abyssal zone) extends from 4,000 meters (13,100 feet) to 6,000 meters (19,700 feet). It is also known as the abyssal zone or the abyss. It is the pitch-black bottom layer of the ocean. The water temperature is constantly near freezing, and only a few creatures can be found at these crushing depths.
The name (abyss) comes from a Greek word meaning "no bottom" because they thought the ocean was bottomless. Three-quarters of the area of the deep-ocean floor lies in this zone. Very few creatures can be found at these depths, most of them are invertebrates such as basket stars and tiny squids.

The abyssal realm is the largest environment for Earth life, covering 300,000,000 square km (115,000,000 square miles), about 60 percent of the global surface and 83 percent of the area of oceans and seas.

Abyssal waters originate at the air-sea interface in polar regions, principally the Antarctic. There, the cold climate produces sea ice and residual cold brine. Because of its high density, the brine sinks and slowly flows along the bottom toward the Equator. The pressures range between 200 and 600 atmospheres.

Hadalpelagic Zone

The deepest zone of the ocean, the hadalpelagic zone extends from 6,000 meters (19,700 feet) to the very bottom, 10,994 meters (36,070 feet) in the Mariana Trench off the coast of Japan. The temperature is constant, just above freezing. The weight of all the water overhead in the Mariana Trench is over 8 tons per square inch.



Even at the very bottom, life exists. In 2005, tiny single-celled organisms called foraminifera, a type of plankton, were discovered in the Challenger Deep trench southwest of Guam in the Pacific Ocean. The deepest a fish have ever been found, Abyssobrotula galatheae, was in the Puerto Rico Trench at 8,372 meters (27,460 feet).Invertebrates such as starfish and tube worms can thrive at these depths.

The Wonders of the Sea
The Great Barrier Reef

Manushi Shah IGCSE 9C

The ocean is a vast, mysterious realm, and one of its greatest marvels is the Great Barrier Reef. Located off Queensland, Australia, it's the largest coral reef system in the world, composed of over 2,900 individual reefs and 900 islands. Spanning 2,300 kilometers, this underwater masterpiece is visible from space, but its true wonders lie beneath the surface, where vibrant life and rich biodiversity thrive, making it one of Earth's most vital ecosystems.

A Growing Natural Wonder

Formed by tiny coral organisms over millions of years, the Great Barrier Reef is often called the "rainforest of the sea" due to its complex and diverse ecosystem.

A World Beneath the Waves

Home to over 1,500 fish species, 400 types of coral, and numerous marine animals like turtles and dolphins, the reef's biodiversity is crucial to maintaining healthy oceans worldwide.

Coral and Algae: A Fragile Partnership Corals and algae share a symbiotic relationship. Algae provide corals with nutrients and vibrant colors through photosynthesis. However, rising sea temperatures and pollution disrupt this balance, leading to coral bleaching, a visible indicator of environmental stress.

Threats to the Reef

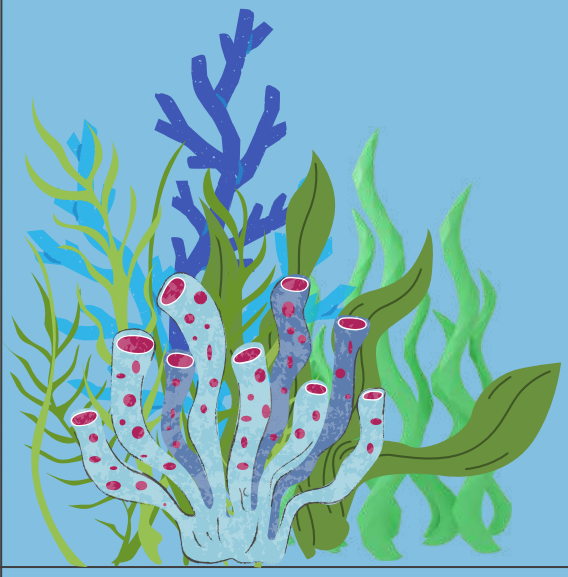
Climate change, pollution, and overfishing threaten the reef's health. Coral bleaching and ocean acidification weaken the delicate coral structures and harm biodiversity. Efforts to save the reef include Australia's Reef 2050 Plan and public awareness campaigns. Individuals can reduce plastic use, support sustainable tourism, and lower their carbon footprint to help protect this natural wonder.

Word Search

Jiana Patel, IGCSE 9B

THE CHEMISTRY OF CORAL REEFS

X	O	K	C	S	V	G	X	W	M	N	J	W	L	C	H	X	I
Z	B	E	W	F	E	G	A	J	Z	V	V	F	L	N	U	D	L
A	W	V	M	I	N	E	R	A	L	H	O	D	W	S	Q	W	I
B	U	B	R	J	Z	C	M	U	H	N	W	Y	N	N	I	D	Q
S	K	Z	U	D	H	T	O	M	C	A	L	C	I	U	M	S	F
C	A	L	G	A	E	E	O	C	A	R	B	O	N	N	N	A	D
H	R	O	I	E	Z	O	X	Y	G	E	N	J	S	A	C	L	K
K	A	P	R	K	Z	S	H	E	L	L	A	F	E	I	Z	T	A
C	A	V	E	A	B	Z	Y	C	A	L	C	X	A	V	J	T	X
N	Z	E	E	K	T	J	Y	V	P	R	I	Q	V	N	C	G	M
S	M	X	F	X	Q	N	T	A	Z	X	D	U	Z	M	Q	J	S
R	T	T	O	Q	G	L	O	M	Y	H	B	S	D	X	P	V	L



- Salt
- Mineral
- Shell
- Reef
- Sea
- Calcium
- Carbon
- Oxygen
- Algae
- Acid

Deep Sea Gigantism

Diva Lakhani, IGCSE 9D

Deep-sea gigantism is a fascinating phenomenon occurring in one of the most mysterious and unexplored regions of our planet: the deep sea, which covers over 60% of Earth's surface.
This realm of eternal darkness, crushing pressure, and freezing temperatures is home to animals that grow much larger than their counterparts in shallower waters, a trait observed in a variety of species, including squids, crabs, and fish.

What Causes Gigantism in the Deep Sea?

1) Cold Temperatures
The deep sea is freezing, with temperatures just above freezing. In these chilly waters, organisms tend to have slower metabolisms, meaning they grow more slowly but for longer periods. Over time, this can result in much larger sizes. The temperature of ocean water varies by location, both in terms of latitude and depth.

2) High Pressure
The deeper you go into the ocean, the higher the pressure. While pressure might seem like a negative force, some scientists believe that it influences the biology of these animals, allowing them to grow larger, though this theory is still being researched. The deep ocean (below about 200 meters depth) has an average temperature of only 4°C (39°F).

3) Food Scarcity
In the deep ocean, food is scarce, and organisms must travel great distances to find nourishment. Larger body sizes can be advantageous in such environments because bigger animals can store more energy and cover more ground when searching for food.

4) Lack of Predators
In shallower waters, animals often need to stay small to avoid predators. However, in the deep sea, there are fewer predators, giving species more freedom to grow larger without the threat of being easily caught.

5) Reproductive Advantages
Larger body sizes may also help with reproduction. In the vastness of the deep sea, finding a mate can be difficult, so some species benefit from being larger as it helps them produce more offspring when they do find a mate.

Bioluminescence

Ananya Hoof , IGCSE 10A

Bioluminescence is the production and emission of light by living organisms. It is a form of chemiluminescence where light energy is released by a chemical reaction involving a light-emitting pigment, called luciferin, and a luciferase, which is the enzyme component.

The light may be produced by the animals themselves or it could be produced by symbiotic bacteria.

Common in the pelagic zone in the ocean, between 200 and 1000 meters deep, bioluminescence is used by animals in many different ways:

Counter illumination camouflage— to merge in with the underwater environment

Mimicry— used to mimic other species and confuse their prey

Mate attraction— the females often light up to attract males

Defence— Many organisms like dinoflagellates light up when predators are detected

Bioluminescence is usually blue or blue-green, but it may be violet, green-yellow, and red in other cases.

The most frequently encountered bioluminescent organisms are the dinoflagellates present in the surface layers of the sea. These can be observed on many beaches around the world, from Betalbatim beach in Goa to San Juan Island in Washington.

About 2.5% of organisms in marine coastal habitats are said to be bioluminescent, and in the pelagic habitats in the eastern Pacific, more than 76% of deep-sea animals are capable of producing light. More than 700 animal genera have light-producing species.

Comics

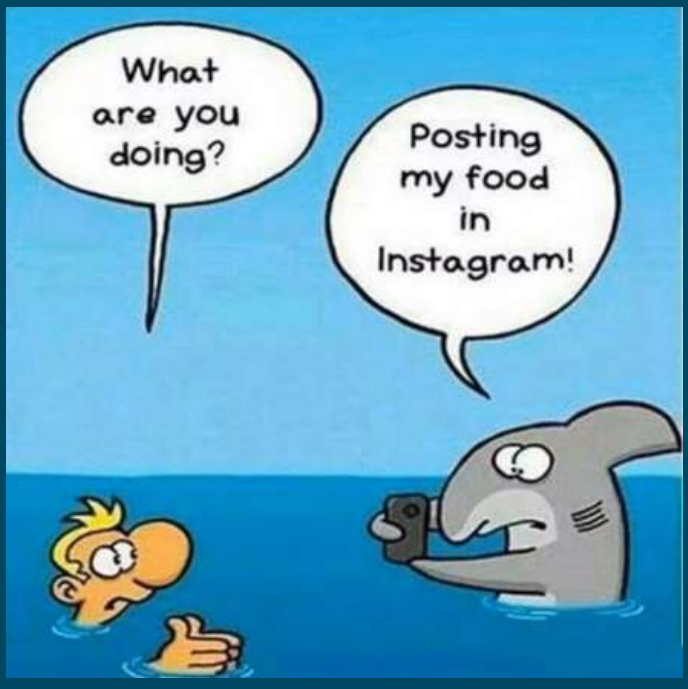
1.


THAT SNOB ONLY LIKES BOTTLED WATER.

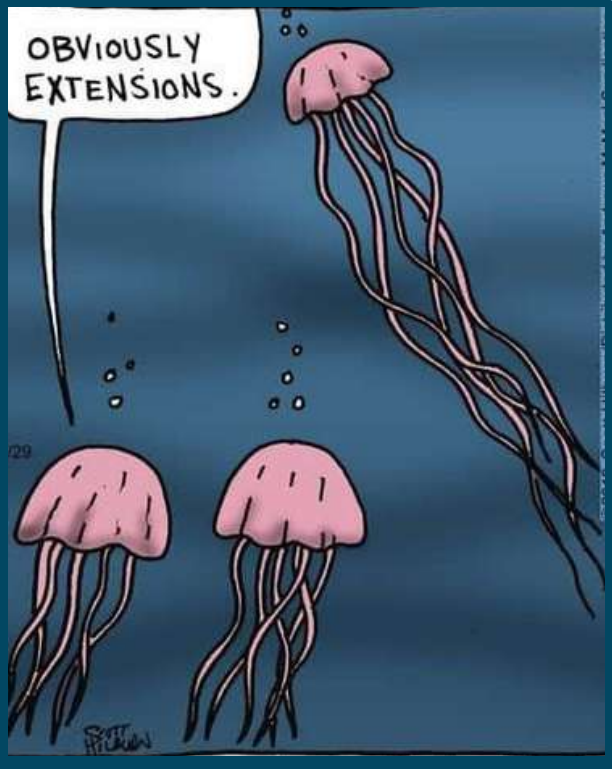
2.


"Do not consume if seal is broken!"

3.


What are you doing?
Posting my food in Instagram!

4.


OBVIOUSLY EXTENSIONS.

Immortal Jellyfish

Miraya Patel, IGCSE 10D

The deep mysterious waters of nature are home to a boundless number of creatures and their astonishing stories. One of these creatures is the Turritopsis dohrnii, known as immortal jellyfish. These jellyfish are known for retreating back to an early stage of their life cycle and outsmarting the process of ageing and death.

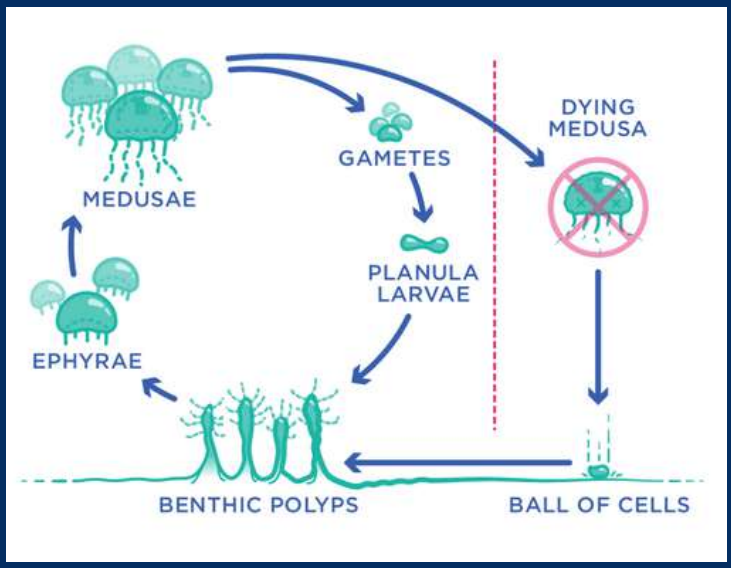
Appearance and habitat

Like other jellyfish, immortal jellyfish are bell-shaped and 4.5mm in width and height when fully grown. They have a bright red stomach in the middle of its bell. Adults usually have 80-90 tentacles. However, the jellyfish look very different in each stage of their life cycle.

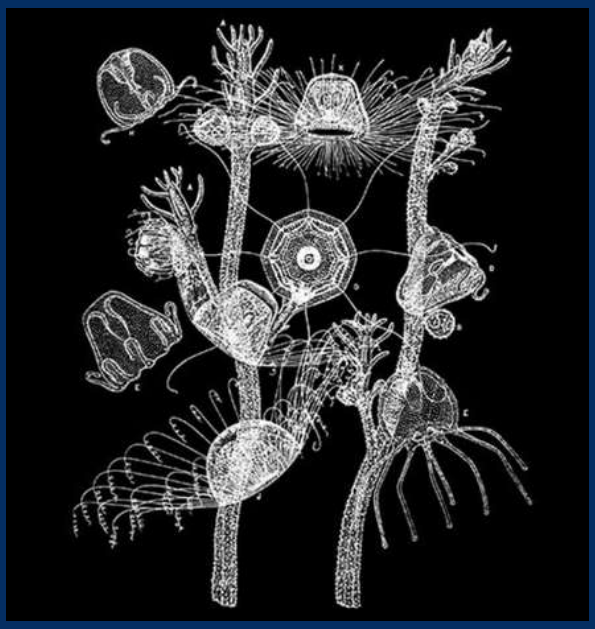
They are usually found in moderate tropical waters and were originally discovered in the Mediterranean Sea. These jellyfish commonly feed on plankton, fish eggs and tiny molluscs and hunt using their tentacles and stomach to attract organisms.

Life Cycle

1. ***Planula Stage*- As soon as fertilisation occurs, a freely swimming miniscule larva known as planula develops. It moves around in search of a hard surface to grow further.**
2. ***Polyp Stage*- Once the larva matures, it grows into a polyp. This represents a tiny organism that stays in a fixed place and eventually starts budding.**
3. ***Medusa Stage*- Once the polyp grows into an adult, it is in the form of a classic jellyfish and can swim freely. This is the stage where the immortal jellyfish reproduce and spend most of their lives.**



Discovery



The species was first discovered in 1883 by a group of scientists. Further research led to the discovery of its immortality about 100 years later. Students Christian Sommer and Giorgio Bavestrello were researching about the larval and medusal form of the jellyfish. When the jar containing medusal jellyfish was checked, they were surprised to see new polyps at the bottom of the jar. This led to the conclusion that under stress or damage conditions, the adult jellyfish in medusal state go back to being polyps.

Transdifferentiation: The ability to live forever

While these species of jellyfish are known as immortal, they cannot always live forever. Yes, they do have the ability to reverse their age but they are still vulnerable to predators, diseases and environmental issues.

Their popularity and uniqueness is based on the process of transdifferentiation. Instead of dying out of starvation or physical damage, these jellyfish suck on their own tentacles to shrink and go back to their polyp stage and become young and sexually undeveloped from an adult stage. Their cells undergo extreme chemical changes and transform back to specialised tissues required for the polyp stage. Transdifferentiation is an efficient way of recycling cells and raises many questions among scientists. Furthermore, this process used by the jellyfish truly intrigues one as the creatures operate a time machine to start their life cycle all over again ; thus cheating the inevitable process of death.

Importance of possessing this adaptation

The immortal jellyfish possessing the ability to reverse their life is helpful in many ways:

- ***Survival*- it helps these jellyfish to survive for longer periods of time and recover from injury and environmental changes. It allows the jellyfish to conserve their energy and prevent extinction or wiping out of their population due to a transmitted disease.**
- ***Preventing predation*- the adaptation helps the jellyfish to change back into smaller form and attach to the ocean floor when under danger from predators.**

The ability of transdifferentiation enables the immortal jellyfish to gain a benefit of evolution and continuation of their species. In addition to not being totally dependent on reproduction to prevent endangerment, the jellyfish can pass on this characteristic to offsprings and can easily overcome hazards.

Further details

Many scientists call this remarkable ability of the jellyfish an adaptation to heal themselves when in danger and want to apply this to human medicine in order to repair and replace damaged cells. Other organisms which have similar abilities of living for long and have been considered immortal include:

Hydra
shows no signs of ageing

Galapagos Giant Tortoise
one of the longest living creatures

Bowhead whale
number of adaptations to help live longer and avoid cancer

Red Sea Urchins
very long lifespan

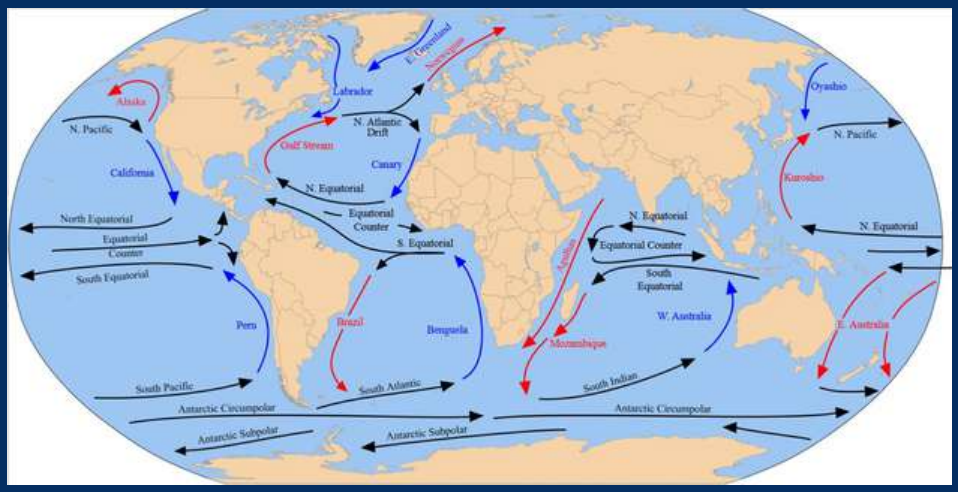
Greenland Shark
world's longest lived vertebrate

Adaptations like these offer exciting possibilities for science, medicine, and technology. While still a subject of ongoing research, the study of immortal jellyfish and other fauna could help us uncover techniques for repairing and rejuvenating tissues for extending human life and improving health in unbelievable ways.

Dynamics of ocean circulation

Jeetmanyu Agrawal, IBDP-1A

Ocean currents play a critical role in regulating Earth's climate, influencing marine ecosystems, and shaping global weather patterns. The study of ocean currents involves understanding the interplay of hydrodynamics, thermodynamics, and geophysical forces. Ocean currents are essential for distributing heat and nutrients across the planet, influencing global climate and marine ecosystems. Surface currents, driven by global wind patterns, the Earth's rotation, and the shape of ocean basins, flow for thousands of kilometres and can reach significant depths. They remain consistent regardless of weather conditions, playing a critical role in climate regulation.



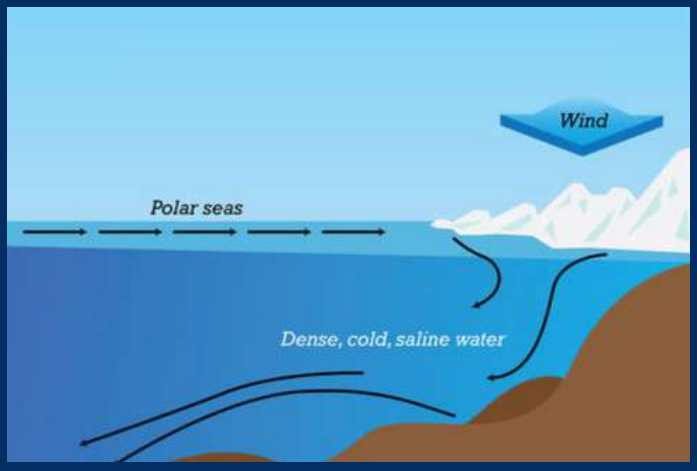
Surface Currents

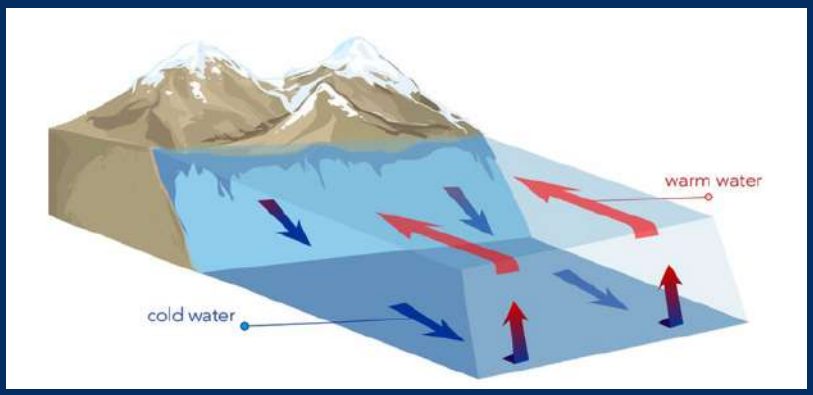
Surface currents are primarily influenced by:

- Global Wind Patterns: Winds on Earth are either global or local. Global winds blow in the same directions all the time and are related to the unequal heating of Earth by the Sun, that is that more solar radiation strikes the equator than the polar regions, and the rotation of the Earth called the Coriolis effect.
- Earth's Rotation (Coriolis Effect): The Coriolis effect causes freely moving objects to appear to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The objects themselves are moving straight, but the Earth is rotating beneath them, so they seem to bend. This effect causes currents to curve to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, steering the flow of both wind and water.
- Ocean Basin Shapes: These influence the paths and boundaries of surface currents, further shaping their dynamics.

Deep Currents

Thermohaline circulation drives deep ocean circulation. Thermo means heat, and haline refers to salinity. Differences in temperature and salinity change the density of seawater. Thermohaline circulation is the result of density differences in water masses because of their different temperature and salinity. Lower temperature and higher salinity yield the densest water. When a volume of water is cooled, the molecules move less vigorously, so the same number of molecules takes up less space, and the water is denser. If salt is added to a volume of water, there are more molecules in the same volume, so it is denser. Changes in temperature and salinity of seawater take place at the surface. Water becomes dense near the poles.





Cold polar air cools the water and lowers its temperature, increasing its salinity. Freshwater freezes out of seawater to become sea ice, which also increases the salinity of the remaining water. This frigid, very saline water is very dense and sinks, a process called downwelling. Two things then happen. The dense water pushes deeper water out of its way, and that water moves along the bottom of the ocean. This deep-water mixes with less dense water as it flows. Surface currents move water into the space vacated at the surface where the dense water sank. Water also sinks into the deep ocean off Antarctica. Since unlimited amounts of water cannot sink to the ocean's bottom, water must rise from the deep ocean to the surface somewhere. This process is called upwelling.

Governing Forces in Ocean Currents

Ocean currents are driven by the interaction of external forces, including:

- **Gravitational Forces: Responsible for maintaining hydrostatic equilibrium, gravity influences vertical pressure gradients.**
- **Earth's Rotation (Coriolis Force): The Coriolis effect causes the deflection of moving water, creating characteristic patterns such as clockwise rotation in the Northern Hemisphere.**
- **Wind Stress: Surface currents, especially in the Ekman layer, respond to wind forces, resulting in spiraling motion due to Coriolis deflection.**
- **Pressure Gradients: Differences in pressure along horizontal planes drive geostrophic currents, which dominate large-scale ocean circulation**

Implications of Current Dynamics

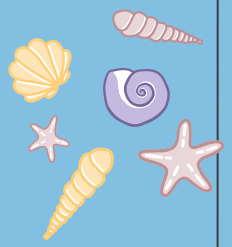
The dynamics of ocean currents are integral to understanding global systems:

- **Climate Regulation: Currents transport heat across latitudes, influencing regional climates. For instance, the Gulf Stream moderates temperatures in Western Europe.**
- **Ecosystem Connectivity: Currents facilitate the distribution of nutrients, impacting primary productivity and marine biodiversity.**
- **Navigation and Engineering: Knowledge of currents aids maritime navigation and informs the design of offshore structures.**

Conclusion

Ocean currents are a cornerstone of Earth's oceanographic and climatic systems. Advances in understanding their dynamics, from hydrodynamic equations to practical observations, continue to unveil their complexity and significance. Bridging the gaps in data collection and theoretical modelling will be crucial in addressing pressing global challenges, such as climate change and marine resource management.

Test your knowledge!



- **What percentage of the ocean has been explored by humans?**
- **What is the main energy source that allows life to thrive around hydrothermal vents in the absence of sunlight?**
- **What is the name of the deepest part of the ocean, located in the Mariana Trench?**
- **What is the largest coral reef system in the world, visible from space?**
- **What is the term for the phenomenon where some deep-sea animals grow larger than their shallow-water counterparts?**
- **What chemical reaction is responsible for bioluminescence in marine organisms?**
- **What species of jellyfish is known for its ability to revert to an earlier stage of its life cycle, making it biologically immortal?**
- **What process allows the immortal jellyfish to start its life cycle over again?**
- **What global current system, also called the “ocean conveyor belt,” plays a critical role in regulating Earth’s climate?**
- **What drives the movement of ocean currents in the deep sea?**

Fun Facts

Mount Everest would fit inside the Mariana Trench.

There's an estimated 20 million tons of dissolved gold in the ocean, but it's too diffuse to mine.

The Blue Whale Is the Largest Animal on Earth.

Deep-Sea Creatures Can Withstand Crushing Pressure.

Oceans Produce Over Half the World's Oxygen.

The Great Barrier Reef is the world's largest living structure, visible from space.

The Point Nemo region is so remote that astronauts on the International Space Station are often closer to it than any humans on Earth.

The Dead Sea Is So Salty You Can Float Without Effort.

There Are More Fish in the Ocean Than Stars in the Milky Way.

Answers

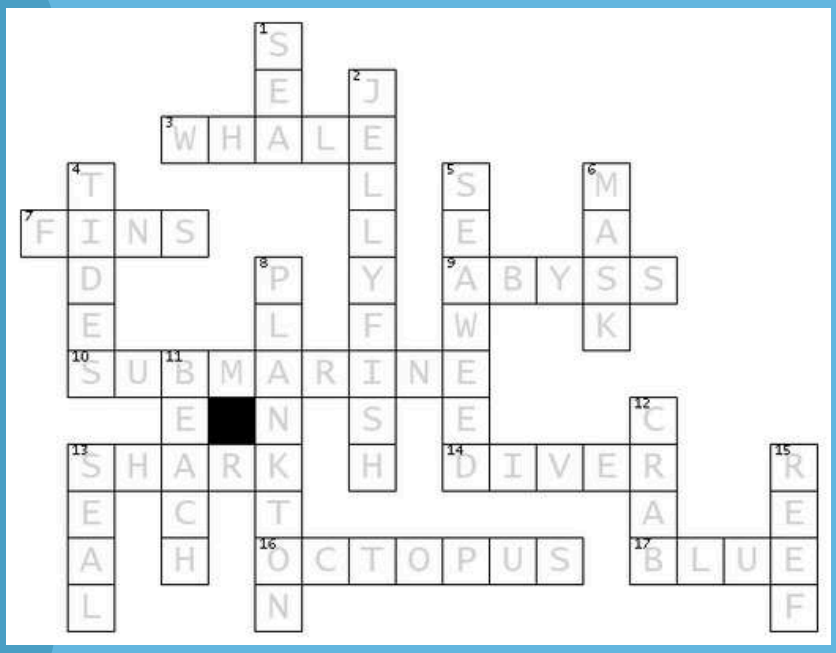
Crossword

ACROSS

3. Whale
7. Fins
9. Abyss
10. Submarine
13. Shark
14. Diver
16. Octopus
17. Byeeeelue

DOWN

1.Jellyfish
2.Sea
4. Tides
5. Seaweed
6. Mask
8. Plankton
11. Beach
12. Crab
13. Seal
15. Reef



Trivia

- 5%
- chemosynthesis
- challenger deep
- The Great Barrier Reef
- Deep-sea gigantism
- The reaction between luciferin and oxygen, catalysed by luciferase
- Turritopsis dohrnii
- Transdifferentiation
- Thermohaline circulation
- Differences in water density caused by variations in temperature and salinity

Word Search

Bibliography

How much have humans explored?

- https://www.nationalgeographic.com/environment/article/mariana-trench
- https://oceanexplorer.noaa.gov/
- https://ocean.si.edu/ocean-life/invertebrates/deep-sea-creatures
- https://ocean.si.edu/ocean-life/invertebrates/deep-sea-creatures

Environmental conditions at different depths

- https://www.noaa.gov/jetstream/ocean/layers-of ocean#:~:text=The%20temperature%20in%20the%20bathypelagic,5850%20pounds%20p er%20square%20inch
- http://www.seasky.org/deep-sea/ocean-layers.html
- Wikipedia.com
- Britannica.com

Deep Sea Gigantism

- https://www.naturalworldfacts.com/deep-sea-gigantism#
- https://en.wikipedia.org/wiki/Deep-sea_gigantism

Bioluminescence

- https://oceanservice.noaa.gov/facts/biolum.html#:~:text=Bioluminescence%20is%20the%20production%20and,members%20of%20the%20same%20species.
- https://en.wikipedia.org/wiki/Bioluminescence

Immortal Jellyfish

- https://www.nhm.ac.uk/discover/immortal-jellyfish-secret-to-cheating-death.html
- https://en.wikipedia.org/wiki/Turritopsis_dohrnii
- https://www.amnh.org/explore/news-blogs/on-exhibit-posts/the-immortal-jellyfish
- https://www.bbcearth.com/news/the-animal-that-lives-forever

Dynamics of ocean circulation

- https://publishing.cdlib.org/ucpressebooks/data/13030/6r/kt167nb66r/pdfs/kt167nb66r_ch13.pdf
- https://open.maricopa.edu/hazards2022/chapter/7-3/


Thank You
Science Magazine Team,
AIS